LIU & ASSOCIATES, INC.

Geotechnical Engineering | Engineering Geology | Earth Science

May 25, 2013

Mr. Nate Perkl
Seattle Pacific Development, LLC
120 SW Everett Mall Way, Suite 100
Everett, WA 98204

Dear Mr. Perkl:

Subject: Geotechnical Engineering Study
Bear Mountain Subdivision
Bear Mountain Road SE and Phillips Road SE
Monroe, Washington
L&A Job No. 12-079

INTRODUCTION

We have completed a geotechnical engineering study for the proposed development of the subject subdivision project located at the above address in Monroe, Washington. The general location of the project site is shown on Plate 1 – Vicinity Map. We understand that the proposed development for the project site is to plat it into 76 single-family residence lots with supporting infrastructure in four phases. The purpose of this study is to characterize the subsurface conditions of the site and provide geotechnical recommendations for grading, erosion mitigation, surface and ground water drainage control, slope stabilization, foundation support to buildings, etc., for the proposed development of the site. Presented in this report are our findings and recommendations for the proposed development.

19213 Kenlake Place NE · Kenmore, Washington 98028
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PROJECT DESCRIPTION

For our use in this study, you provided us with a topographic/subdivision plan of the proposed development for the site. According to this plan, the subject site is composed of a rectangle land and a panhandle land extending westward from the west side of the rectangle. The rectangle portion of the site is lying on the west side of Phillips Ridge Road SE and behind one row of residences on the west side of Bear Mountain Road SE, and the panhandle portion extends is a part of the Phase I area extending all the way to Roosevelt Road. The proposed development is to be accessed from the intersection of Bear Mountain Road SE and Phillips Ridge Road SE on its east side and from Roosevelt Road on its west end of the panhandle. The building lots will be accessed via a network of access roadways into the interior of the development. Most of the west side of the rectangle portion of the site is consisted of wet lands, with the to-be-developed areas to stay clear of the wetlands and their buffer zones. Stormwater over impervious surfaces will be collected and dispersed onto wetland buffer zones to replenish wetlands wherever feasible.

SCOPE OF SERVICES

Our scope of services for this study comprises specifically the following:

1. Review the geologic and soil conditions at the site based on a published geologic map.
2. Explore subsurface conditions of the site with backhoe test pits to a firm bearing soil stratum or to the maximum depth (about 10 feet) capable by the backhoe used in excavating the test pits, whichever occurs first.

3. Perform necessary geotechnical analyses and provide geotechnical recommendations for grading, slope stabilization, erosion mitigation, surface and ground water drainage control, stormwater detention pond, foundation support to buildings, etc., based on subsurface conditions encountered by the test pits and results of our geotechnical analyses.

4. Prepare a written report to present our findings, conclusions, and recommendations.

SITE CONDITIONS

SURFACE CONDITIONS

The subject site is situated at the south foothill of a highland that lies north of the flood plain of the nearby Skykomish River and its tributaries. The terrain within the rectangle portion of the site consists of a number of moderately-sloped, elevated knolls and low-lying valleys at its northeast corner and in most of its southern two thirds which are surrounded by wetlands and their buffer zones lying mostly to the west. This portion of the site is currently vacant and undeveloped. The west half of the panhandle portion of the site is currently occupied by a house, a detached shop and a chicken coop structure. We understand that these structures are to be demolished to make way for the proposed development. The ground in this portion of the site generally slopes down gently eastward then down moderately steeply northward and southward to the offsite wetlands that flanking the northern portion of this area. Both the rectangle portion and the undeveloped northern area of the panhandle portion of the site are dotted by tall, mature deciduous trees with occasional evergreens mixed and covered with dense shrubs and underbrush.

GEOLOGIC SETTING

The Surficial Geologic Map of the Skykomish and Snoqualmie Rivers Area, Snohomish and King Counties, Washington, by Derek B Booth, published by U. S. Geological Survey in 1990, was referenced for geologic and soil conditions. The subject site is just outside of the coverage of this geologic map. According to this map, the surficial soil unit at and in the vicinity of the subject site is likely Young Alluvium deposits (Q_{yal}) consisting of geologically recent sediment transported and deposited by flooding water of the nearby Skykomish River and its tributaries.

The young alluvium soil unit, however, was not encountered by the test pits excavated on the subject site. Instead, a surficial soil unit of fine-sandy to clayey silt was found underlying most of the site at shallow depth. This fine-grained soil unit appears to be of Transitional Beds deposit. The deposits of the transitional beds soil unit are composed of glacial and non-glacial deposits of interbedded silt, fine sand, occasional gravel, and diamicts of indeterminate age and origin. These deposits are generally very-stiff to hard and are of extremely low permeability in their native undisturbed state.

SOIL CONDITION

Subsurface conditions of the site were explored with 15 test pits scattered over the site. The test pits were excavated on August 22, 2012 and May 17, 2013, with a tire-mounted backhoe to depths from 5.0 to 8.5 feet. The approximate locations of the test pits are shown on Plate 2 - Site and Exploration Location Plan. The test pits were located with either a tape measure or by visual reference to existing topographic features in the field and on the topographic survey map, and their locations should be considered as only accurate to the measuring method used.

A geotechnical engineer from our office was present during subsurface exploration, who examined the soil and geologic conditions encountered and completed logs of the test pits. Soil samples obtained from each soil layer in the test pits were visually classified in general accordance with United Soil Classification System, a copy of which is presented on Plate 3. Detailed descriptions of soils encountered during site exploration are presented in test pit logs on Plates 4 through 11.

The test pits encountered a layer of loose organic topsoil, from about 8 to 15 inches thick, mantling the site. The topsoil is generally underlain by a layer of weathered soil of brown, loose to medium-dense, silty fine sand with a trace of gravel, or brown-gray, soft, fine-sandy to clayey silt with occasional cobble locally, from about 0.8 to 2.6 feet thick, except that this soil layer was absent n Test Pit 14. Underlying the weathered soils is mostly a light-gray deposit of very-stiff to hard, fine-sandy to clayey silt to the depths explored. The exception to this is a very-dense, weakly-cemented, till-like deposit of silty, gravelly, fine sand deposit with occasional cobble, which was encountered underlying the weathered soils toward the bottom of Test Pits 4, 5 and 15.

GROUNDWATER CONDITION

Groundwater was not encountered in any of the test pits excavated on the site. The prevailing fine-sandy to clayey silt and the occasional till-like deposit underlying the site at shallow depth is of extremely low permeability and would perch stormwater infiltrating into the more permeable surficial soils. The amount of and the depth to the near-surface perched groundwater would fluctuate seasonally, depending on precipitation, surface runoff, ground vegetation cover, site utilization, and other factors. The perched

groundwater may dry up completely during the dryer summer and early fall seasons and accumulate and rise in the wet winter and early spring seasons.

GEOLOGIC HAZARDS AND MITIGATION

Landslide Hazard

The to-be-developed areas of the site are generally gently to moderately sloped. The site is underlain at shallow depth mostly by very-stiff to hard silt and occasionally by very-dense till-like soil. These deposits are of moderately-high to high shear strength and are of high resistance against slope failure. It is our opinion that as long as the site is properly and adequately drained, the potential for deep-seated slides to occur on the site should be minimal.

Erosion Hazard

The surficial topsoil and weathered soils are of low resistance against erosion, while the underlying very-stiff to hard silt and/or very-dense till-like deposits are of moderately high resistance against erosion. There is a remote chance that erosion may occur in the weaker surficial soils over the steeper areas of the site if it is devoid of vegetation cover and overly saturated. Progressive erosion can lead to shallow, skin-type mudflows in the steeper areas. To mitigate such erosion hazard, vegetation outside of construction limits should be preserved and maintained. Unpaved exposed finished ground within the site resulted from construction activities should be re-seeded and re-vegetated as soon as possible. Concentrated stormwater should not be discharged uncontrolled onto the ground within or adjacent to the site. Stormwater over impervious surfaces, such as roofs and paved roadways/driveways, should be captured by underground drain line systems connected to roof downspouts and by catch basins installed in paved roadways/driveways.

Water collected by these drainage systems should be tightlined to discharge into a storm sewer or suitable stormwater disposal facilities such or distribution trench systems or spreader pipe systems to disperse water into the adjacent wetlands.

Seismic Hazard

The Puget Sound region is in an active seismic zone. The to-be-developed areas of the site is generally gently to moderately sloped. Also, the site is underlain at shallow depth mostly by very-stiff to hard silt and occasionally by very-dense till-like deposits of moderately-high to high shear strength. Therefore, the potential for seismic hazards, such as landslides, liquefaction, lateral soil spreading, to occur on the site should be minimal if the erosion mitigation, drainage control, site stabilization measures recommended in this report are fully implemented. The residences to be constructed on the site, however, should be designed for seismic forces induced by strong earthquakes. Based on the soil conditions encountered by the test pits, it is our opinion that Seismic Use Group I and Site Class D should be used in the seismic design of the proposed residences in accordance with the 2009 International Building Code (IBC).

DISCUSSIONS AND RECOMMENDATIONS

GENERAL

Based on the soil conditions encountered by the test pits excavated on the site, it is our opinion that the site is suitable for the proposed development from the geotechnical engineering viewpoint, provided that the recommendations in this report are fully implemented and observed during construction. The fine-sandy to clayey silt underlying the site at shallow depth can be easily disturbed when saturated and may significantly complicate construction work during the wet winter months. Therefore, we recommend

grading and foundation construction work be carried out and completed during the dryer period from April 1 through October 31. Conventional footing foundations constructed on or into the underlying very-stiff to hard silt and/or the very-dense till-like soil may be used to support the residences to be built on the lots. Unsuitable surficial topsoil and weathered soil should be stripped within footprints of the roadways/driveways and areas of structural fill.

TEMPORARY DRAINAGE AND EROSION CONTROL

The onsite soils contain a high percentage of fines which are sensitive to moisture and can be easily disturbed by construction traffic when saturated. A layer of clean, 2-to-4-inch quarry spalls should be placed over areas of frequent traffic, such as the entrance to the site, as required, to protect the subgrade soils from disturbance by construction traffic.

A silt fence should be installed along the downhill sides of construction areas to minimize transport of sediment onto neighboring properties, wetlands or streets. The bottom of the filter cloth of silt fences should be anchored in a trench filled with onsite soil.

Interceptor ditches or trench drains should be installed around the construction areas, as required, to intercept and drain away storm runoff and near-surface groundwater seepage. Water captured by such ditches or trench drains should be discharged onto well-vegetated buffer zones of the wetlands through perforated spreader pipe dispersion pipes.

Spoil soils should be hauled off of the site as soon as possible. Spoil soils and imported structural fill material to be stored on site should be located in areas where the ground

surface is no steeper than 15% grade, and should covered with plastic tarps securely weighted down with sandbags, as required, for protection against erosion.

SITE PREPARATION AND GENERAL GRADING

The existing structures and their foundations in the panhandle portion of the site should be completed removed. Vegetation within construction limits should be cleared and grubbed. Loose topsoil and weak weathered soil should be completely stripped down to very-stiff to hard silt and/or very-dense till-like soil within the building pads of the residences and within roadways and paved driveways. The exposed soils should be compacted to a non-yielding state with a mechanical compactor and proof-rolled with a piece of heavy earthwork equipment.

EXCAVATION AND FILL SLOPES

Under no circumstance should excavation slopes be steeper than the limits specified by local, state and federal safety regulations if workers have to perform construction work in excavated areas. Unsupported temporary cuts greater than 4 feet in height should be no steeper than 1H:1V in topsoil and weathered soil and no steeper than 1/2H:1V in the underlying very-stiff to hard silt and/or the very-dense till-like soil. Permanent cut banks should be no steeper than 2H:1V in topsoil and weathered soil and no steeper than 1-1/2H:1V in the underlying very-stiff to hard silt and/or the very-dense till-like soil. The soil units and the stability of cut slopes should be observed and verified by a geotechnical engineer during excavation.

Permanent fill embankments required to support structural or traffic load should be constructed with compacted structural fill placed over undisturbed, proof-rolled, firm,

native, silt and/or till-like soil after the surficial unsuitable soils are completely stripped. Permanent fill to be placed over slopes steeper than 15 percent grade should be retained structurally. The exposed ground exceeding 20 percent grade should be benched with vertical steps not exceeding 4 feet tall after stripping of surficial unsuitable soils and prior to placing structural fill. The slope of permanent fill embankments should be no steeper than 2-1/4H:1V. Upon completion, the sloping face of permanent fill embankments should be thoroughly compacted to a non-yielding state with a hoe-pack.

The above recommended cut and fill slopes are under the assumption that groundwater seepage would not be encountered during construction. If groundwater is encountered, the construction work should be immediately halted and the slope stability re-evaluated. The slopes may have to be flattened and other measures taken to stabilize the slopes. Stormwater should not allowed to flow uncontrolled over cut and fill slopes. Permanent cut slopes or fill embankments should be seeded and vegetated as soon as possible for erosion protection and long-term stability, and should be covered with clear plastic sheets, as required, to protect them from erosion until the vegetation is fully established.

STRUCTURAL FILL

Structural fill is the fill that supports structural or traffic load. Structural fill should consist of clean granular soils free of organic, debris and other deleterious substances and with particles not larger than three inches. Structural fill should have a moisture content within one percent of its optimum moisture content at the time of placement. The optimum moisture content is the water content in the soils that enable the soils to be compacted to the highest dry density for a given compaction effort. The onsite fine-sandy to clayey silt soil should not be used as structural fill. Imported material to be used as

structural fill should be clean, free-draining, granular soils containing no more than 5 percent by weight finer than the No. 200 sieve based on the fraction of the material passing No. 4 sieve, and should have individual particles not larger than three inches.

The ground over which structural fill is to be placed should be prepared in accordance with recommendations in the SITE PREPARATION AND GENERAL GRADING and EXCAVATION AND FILL SLOPES sections of this report. Structural fill should be placed in lifts no more than 10 inches thick in its loose state, with each lift compacted to a minimum percentage of the maximum dry density determined by ASTM D1557 (Modified Proctor Method) as follows:

Application	% of Maximum Dry Density
Within building pads and under foundations	95%
Roadway/driveway subgrade	95% for top 3 feet and 90% below
Retaining/foundation wall backfill	92%
Utility trench backfill	95% for top 4 feet and 90% below

STORMWATER DETENTION PONDS

Open detention ponds may be used to store collected stormwater. Cut banks and fill embankments may be required to construct the ponds. In order to retain water, the base of fill embankment of the pond should be keyed at least 18 inches into the underlying very-stiff to hard silt and/or very-dense till-like soil.

Fill embankment should be constructed of clean, fine-grained, fine-sandy to clayey silt silty or clay soil, free of organics and other deleterious substances, with the following gradation requirements:

% Passing	U.S. Standard Sieve No.
100	20
90	40
80	60
65	100
25	200

Slope faces of fill embankments should be no steeper than 3H:1V for the inside slopes and no steeper than 2H:1V for the outside slopes of the pond. Fill should be placed in lifts no more than 8 inches thick in loose state, with each lifts compacted to at least 92% of the maximum dry density determined by ASTM D1557 (Modified Proctor method) with a sheep-foot or elephant foot mechanical compactor. Cut banks of the pond should be no steeper than 2-1/2H:1V.

Both the fill and cut sloping faces should be compacted to a non-yielding state with a mechanical compactor after the completion of the pond. The pond slopes should be hydroseeded as soon as possible for erosion control with a seed mixture of 30% Kentucky Bluegrass, 30% Creeping Red Fescue and 40% Perennial Rye.

ONSITE STORMWATER DISPOSAL

Stormwater collected over impervious surfaces, such as roofs and paved roadways/driveways, may be disposed onto adjacent wetland buffer zones via tightlines releasing water into dispersion systems wherever feasible. The dispersion systems may consist of distribution trenches or elevated spreader pipes located in well-vegetated areas within the wetland buffer zones. Storm runoff over pavement should be routed through

catch basins equipped with oil/water separators before being released into the dispersion systems.

The distribution trenches should be about 30 to 50 feet long and about 24 inches wide by 30 inches deep, filled with 3/4 to 1-1/2 inch washed gravel, as shown on Plate 12. The downstream rims of the distribution trenches should be a few inches lower than their upstream rims, and should be level to spread water overflowing from the distribution trenches into sheet flow onto well-vegetated areas in wetland buffer zones. Water released into such dispersion systems would recharge the wetlands.

The spreader pipe systems should be constructed of 4-inch-diameter, rigid, perforated, PVC or aluminum pipes, set level at about 2 to 4 feet above the ground surface over well-vegetated areas in wetland buffer zones, as shown on Plate 13. The spreader pipes should be supported on and anchored to 2-inch-diameter, schedule 80 (2.375-inch outside diameter by 0.218-inch wall), galvanized, steel pipe piles, spaced at no more than 8 feet on centers, driven at least 6 feet into the ground. The total length of spreader pipes of each system should be calculated based on one lineal foot of pipe per every 50 square feet of impervious area. The spreader pipes may be looped around to space at least 5 feet on centers. Water discharged through the spreader pipe systems will be able to evaporate into the ambience, absorbed by root system of vegetation cover, with only a small fraction infiltrating into the ground, and water flowing out of the spreader pipe systems would be at a very low velocity. Therefore, the spread pipe dispersion systems should not cause erosion or soil sloughing problem.

BUILDING FOUNDATIONS

Conventional footing foundations may be used to support the residences to be constructed on the site. The footing foundations should be placed on or into the underlying, very-stiff to hard and/or very-dense till-like soil, or on structural fill placed over this undisturbed competent basal soils. Water should not be allowed to accumulate in excavated footing trenches. Disturbed soils in footing trenches should be completely removed down to native, undisturbed, fresh till soil prior to pouring concrete for the footings.

If the above recommendations are followed, our recommended design criteria for footing foundations are as follows:

- The allowable soil bearing pressure for design of footing foundations, including dead and live loads, should be no greater than 2,500 psf. The footing bearing soils should be verified by a geotechnical engineer after the footing trenches are excavated and before the footings poured.

- The minimum depth to bottom of perimeter footings below adjacent final exterior grade should be no less than 18 inches. The minimum depth to bottom of the interior footings below top of floor slab should be no less than 12 inches.

- The minimum width should be no less than 16 inches for continuous footings, and no less than 24 inches for individual footings, except those footings supporting light-weight decks or porches.

A one-third increase in the above recommended allowable soil bearing pressure may be used when considering short-term, transitory, wind or seismic loads. For footing foundations designed and constructed per recommendations above, we estimate that the

maximum total post-construction settlement of the buildings should be 3/4 inch or less and the differential settlement across building width should be 1/2 inch or less.

Lateral loads on the proposed buildings may be resisted by the friction force between the foundations and the subgrade soils or the passive earth pressure acting on the below-grade portion of the foundations. For the latter, the foundations must be poured "neat" against undisturbed soils or backfilled with a clean, free-draining, compacted structural fill. We recommend that an equivalent fluid density (EFD) of 300 pcf (pounds per cubic foot) for the passive earth pressure be used for lateral resistance. The above passive pressure assumes that the backfill is level or inclines upward away from the foundations for a horizontal distance at least twice the depth of the foundations below the final grade. A coefficient of friction of 0.50 between the foundations and the subgrade soils may be used. The above soil parameters are unfactored values, and a proper factor of safety should be used in calculating the resisting forces against lateral loads on the buildings.

SLAB-ON-GRADE FLOORS

Slab-on-grade floors, if used for the residences to be constructed on the site, should be placed on firm subgrade soil prepared as outlined in the SITE PREPARATION AND GENERAL EARTHWORK and the STRUCTURAL FILL sections of this report. Where moisture control is critical, the slab-on-grade floors should be placed on a capillary break which is in turn placed on the compacted subgrade. The capillary break should consist of a minimum four-inch-thick layer of clean, free-draining, 7/8-inch crushed rock, containing no more than 5 percent by weight passing the No. 4 sieve. A vapor barrier, such as a 6-mil plastic membrane, may be placed over the capillary break, as required, to keep moisture from migrating upwards.

PAVED ROADWAYS/DRIVEWAYS

Performance of roadway and driveway pavement is critically related to the conditions of the underlying subgrade soils. We recommend that the subgrade soils under the roadways/driveways be treated and prepared as described in the SITE PREPARATION AND GENERAL EARTHWORK section of this report. Prior to placing base material, the subgrade soils should be compacted to a non-yielding state with a mechanical compactor and proof-rolled with a piece of heavy construction equipment, such as a fully-loaded dump truck. Any areas with excessive flexing or pumping should be over-excavated and re-compacted or replaced with a structural fill or crushed rock placed and compacted in accordance with the recommendations provided in the STRUCTURAL FILL section of this report.

We recommend that a layer of compacted, 7/8-inch crushed rock base (CRB), be placed for the roadways/driveways. This crushed rock base should be at least 6 inches for the public roadways and 4 inches for the private driveways. This crushed rock base may be reduced to a 2-to-3-inch layer of leveling course consisting of 7/8-inch crushed rock if the roadways/driveways are to be based on cuts into undisturbed, very-dense, fresh till soils. This crushed rock base should be overlain with a 3-inch asphalt treated base (ATB) topped by a 2-inch-thick Class B asphalt concrete (AC) surface course for the public roadways and overlain a 3-inch-thick Class B asphalt concrete (AC) surface course for the private driveways.

DRAINAGE CONTROL

Building Footprint Excavation

Pit excavation for the proposed buildings and the stormwater detention pond, if encountering groundwater seepage, should have the bottom of excavation sloped slightly and ditches excavated along bases of the cut banks to direct collected groundwater into sump pits from which water can be pumped out. A layer of 2-inch crushed rock should be placed over footing bearing subgrade soils, as required, to protect the soils from disturbance by construction traffic. This crushed rock base should be built to a few inches above groundwater level, but not less than 6 inches thick. The crush rock base should be compacted in 12-inch lifts to a non-yielding state with a vibratory mechanical compactor.

Runoff Over Impervious Surfaces

Storm runoff over impervious surfaces, such as roofs and paved roadways/driveways, should be collected by underground drain line systems connected to downspouts and by catch basins installed in paved roadways/driveways. Stormwater thus collected should be tightlined to discharge into a storm sewer or a detention pond or suitable stormwater disposal facilities such as dispersion systems in the wetland buffer zones as recommended in this report.

Building Footing Drains

A subdrain should be installed, around the perimeter footings of each of the buildings to be constructed on the site. The subdrains should consist of a 4-inch-minimum-diameter, perforated, rigid, drain pipe, laid a few inches below bottom of the perimeter footings of the buildings. The trenches and the drain lines should have a sufficient gradient (0.5%

minimum) to generate flow by gravity. The drain lines should be wrapped in a non-woven filter fabric sock and completely enclosed in clean washed gravel. The remaining trenches may be backfilled with clean onsite soils. Water collected by the perimeter footing subdrain systems should be tightlined, separately from the roof and surface stormwater drain lines, to discharge into a storm sewer or suitable stormwater disposal facilities.

Surface Drainage

Water should not be allowed to stand in any areas where footings, on-grade slabs, or pavement is to be constructed. Finish ground surface should be graded to direct surface runoff away from the residences to be constructed on the site. We recommend the finish ground be sloped at a gradient of 3 percent minimum for a distance of at least 10 feet away from the buildings, except in the areas to be paved.

Cleanouts

Sufficient number of cleanouts at strategic locations should be provided for underground drain lines. The underground drain lines should be cleaned and maintained periodically to prevent clogging.

RISK EVALUATION STATEMENT

The subject site is underlain at shallow depth by very-stiff to hard silt and/or very-dense till-like soil. These soils are of moderately-high to high shear strength and the site should be quite stable. It is our opinion that if the recommendations in this report are fully implemented and observed during construction and following the completion of construction, the areas disturbed by construction will remain stable and will not increase

the potential for soil movement. In our opinion, the risk for damages to the proposed development and from the development to adjacent properties from soil instability should be minimal.

LIMITATIONS

This report has been prepared for the specific application to this project for the exclusive use by Seattle Pacific Development, LLC, and its associates, representatives, consultants and contractors. We recommend that this report, in its entirety, be included in the project contract documents for the information of the prospective contractors for their estimating and bidding purposes and for compliance with the recommendations in this report during construction. The conclusions and interpretations in this report, however, should not be construed as a warranty of the subsurface conditions. The scope of this study does not include services related to construction safety precautions and our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in this report for design considerations. All geotechnical construction work should be monitored by a geotechnical engineer during construction.

Our recommendations and conclusions are based on the geologic and soil conditions encountered in the test pits, and our experience and engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty, expressed or implied, is made.

The actual subsurface conditions of the site may vary from those encountered by the test pits excavated on the site. The nature and extent of such variations may not become evident until construction starts. If variations appear then, we should be retained to re-evaluate the recommendations of this report, and to verify or modify them in writing prior to proceeding further with the construction of the proposed development of the site.

CLOSURE

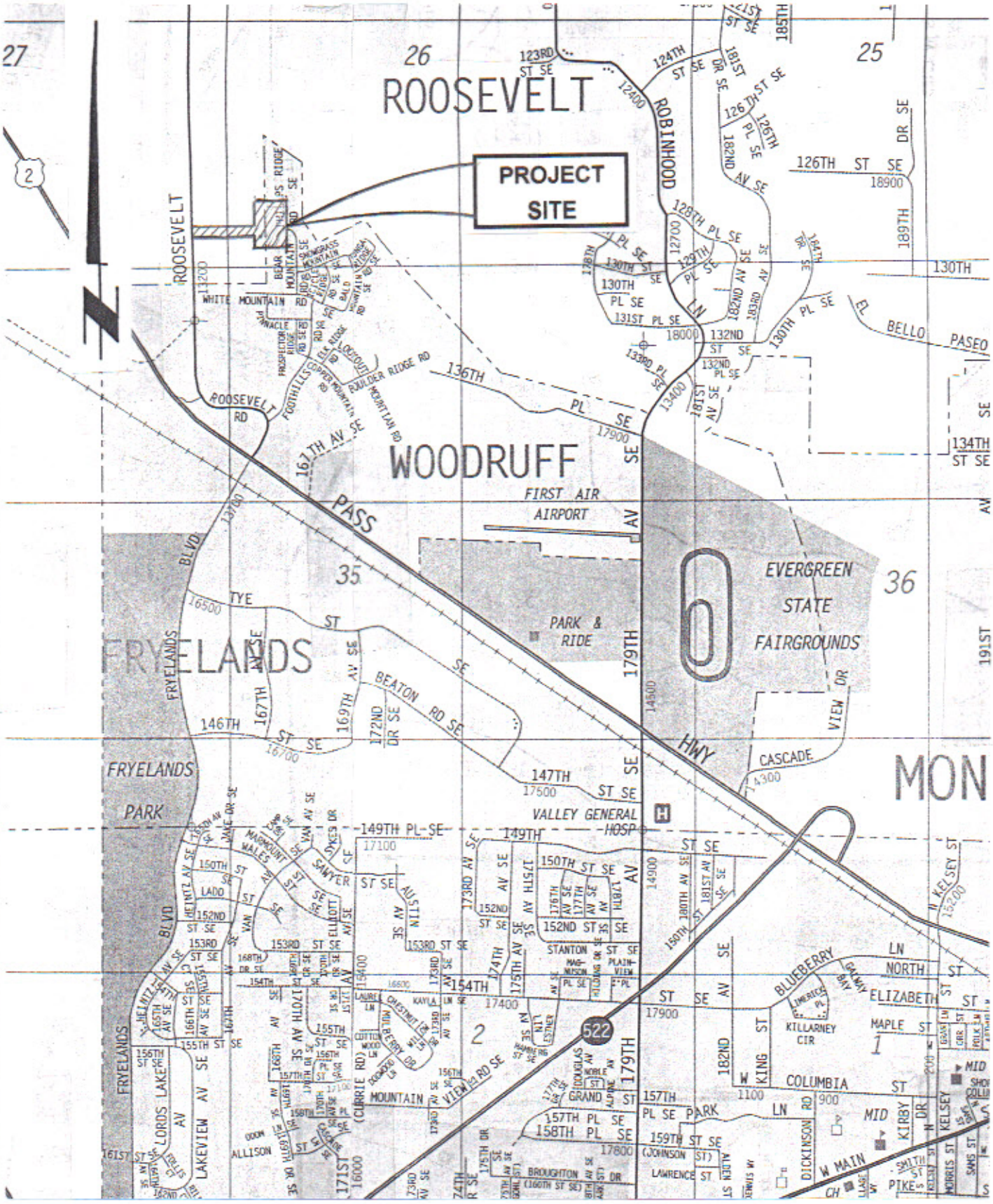
We are pleased to be of service to you on this project. Please feel free to call us if you have any questions regarding this report or need further consultation.

JEONG S. LIU
STATE OF WASHINGTON
27589
REGISTERED
PROFESSIONAL ENGINEER
5/25/2013

Yours very truly,
LIU & ASSOCIATES, INC.

J. S. (Julian) Liu, Ph.D., P.E.
Consulting Geotechnical Engineer

Thirteen plates attached



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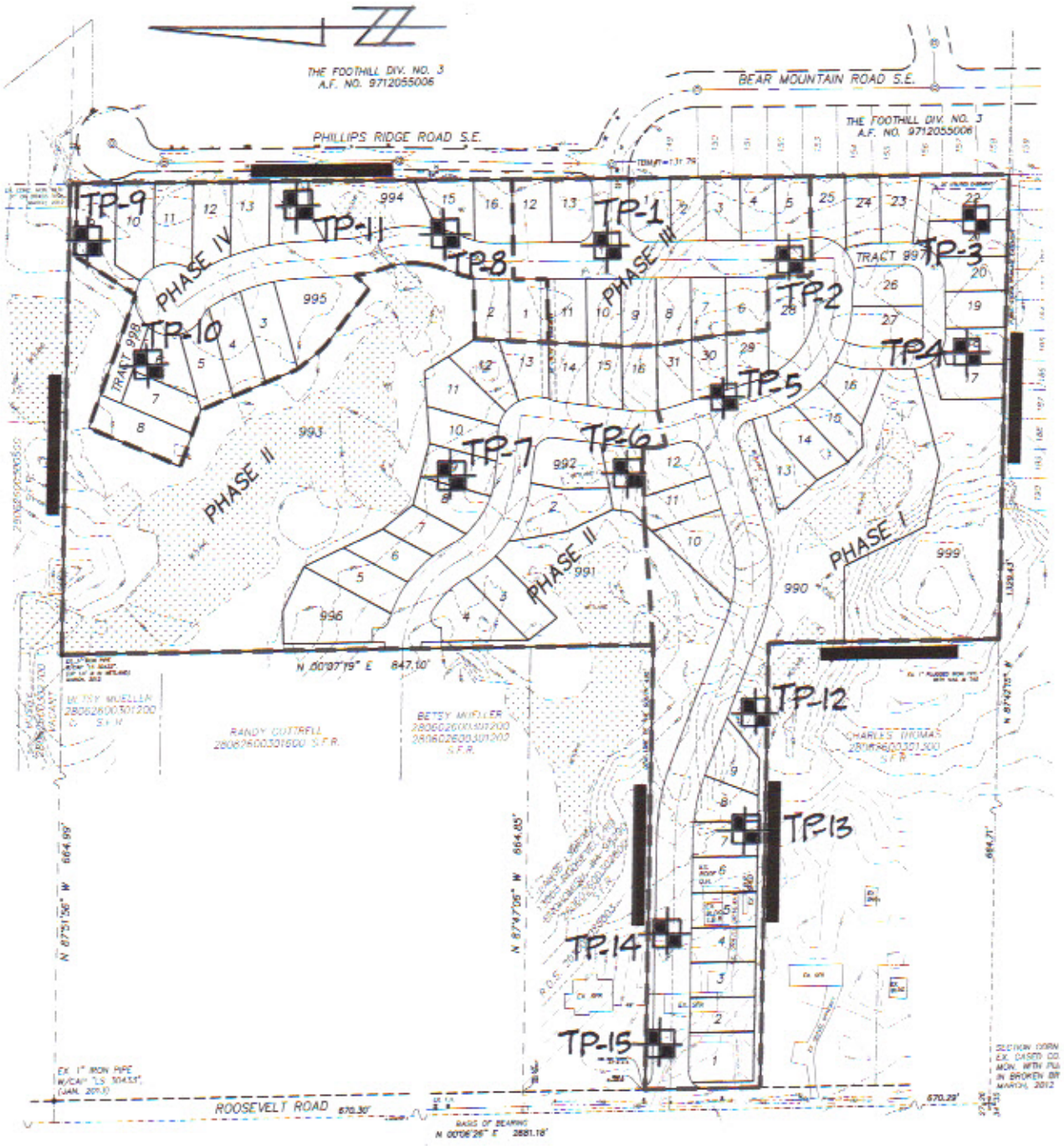
VICINITY MAP
BEAR MOUNTAIN SUBDIVISION
BEAR MOUNTAIN ROAD & PHILLIPS RIDGE ROAD
MONROE, WASHINGTON

JOB NO. 12-079	DATE 8/25/2012	PLATE 1



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SITE AND EXPLORATION LOCATION PLAN
BEAR MOUNTAIN SUBDIVISION
BEAR MOUNTAIN ROAD & PHILLIPS RIDGE ROAD
MONROE, WASHINGTON

JOB NO. 12-079	DATE 5/22/2013	PLATE 2

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS MORE THAN 50% RETAINED ON THE NO. 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE-GRAINED SOILS MORE THAN 50% PASSING ON THE NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50%	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILTY AND CLAY LIQUID LIMIT 50% OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC SILT, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS

NOTES:

1. FIELD CLASSIFICATION IS BASED ON VISUAL EXAMINATION OF SOIL IN GENERAL ACCORDANCE WITH ASTM D2488-83.
2. SOIL CLASSIFICATION USING LABORATORY TESTS IS BASED ON ASTM D2487-83.
3. DESCRIPTIONS OF SOIL DENSITY OR CONSISTENCY ARE BASED ON INTERPRETATION OF BLOW-COUNT DATA, VISUAL APPEARANCE OF SOILS, AND/OR TEST DATA.

SOIL MOISTURE MODIFIERS:

DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH

SLIGHTLY MOIST - TRACE MOISTURE, NOT DUSTY

MOIST - DAMP, BUT NO VISIBLE WATER

VERY MOIST - VERY DAMP, MOISTURE FELT TO THE TOUCH

WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED FROM BELOW WATER TABLE

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UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 3

TEST PIT NO. 1

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with roots to 1-in ϕ, slightly moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, trace gravel, slightly moist			
3					
4	ML	Light-gray with yellowish stains, very-stiff to hard, clayey SILT, moist			
5					
6					
7		Test pit terminated at 6.0 ft; groundwater not encountered.			
8					
9					
10					

TEST PIT NO. 2

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with fine roots, slightly moist (TOPSOIL)			
2	SM	Brown, loose to medium-dense, silty fine SAND, few roots, slightly moist			
3					
4	ML	Light-gray, very-stiff to hard, fine-sandy to clay SILT, some gravel and occasional cobble at interface with the soil layer above			
5					
6					
7					
8		Test pit terminated at 6.5 ft; groundwater not encountered.			
9					
10					

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JOB NO. 12-079 DATE 8/23/2012 PLATE 4

TEST PIT NO. 3

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with roots to 1/2-in ϕ, slightly moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, some gravel, slightly moist			
3	SM	Light-gray, very-stiff to hard, clayey SILT, with thin fine sandy silt bedding, slightly moist			
4					
5					
6					
7		Test pit terminated at 6.5 ft; groundwater not encountered.			
8					
9					
10					

TEST PIT NO. 4

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown to black, loose, organic, silty fine SAND, moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, moist			
3	ML	Light-brown to light-gray, very-stiff to hard, fine-sandy to clayey SILT, occasional gravel and cobble, moist			
4					
5	SM	Brown, very-dense, silty, gravelly, fine SAND, occasional cobble, weakly-cemented, till like, moist			
6					
7		Test pit terminated at 6.0 ft; groundwater not encountered.			
8					
9					
10					

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JOB NO. 12-079 DATE 8/23/2012 PLATE 5

TEST PIT NO. 5

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown to black, loose, organic, silty fine SAND, with roots to 1/2-in ϕ, slightly moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, trace gravel, slightly moist			
3					
4	SM	Light-gray, very-dense, gravelly, silty, fine SAND, some cobble, weakly-cemented, moist (VASHON TILL)			
5					
6		Test pit terminated at 5.0 ft; groundwater not encountered.			
7					
8					
9					
10					

TEST PIT NO. 6

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with roots to 1/2-in ϕ, slightly moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, trace gravel and cobble, slightly moist			
3					
4	SM	Brown, dense, silty, gravelly, fine to medium SAND, some cobble, moist			
5					
6	ML	Light-brown to light-gray, dense to hard, fine-sandy SILT, moist			
7					
8		Test pit terminated at6.5 ft; groundwater not encountered.			
9					
10					

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JOB NO. 12-079 | DATE 8/23/2012 | PLATE 6

TEST PIT NO. 7

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with roots, slightly moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, trace gravel, with roots to 2-in ϕ, slightly moist			
3					
4	ML	Light-gray with yellowish stains, very-stiff to hard, fine-sandy to clayey SILT, slightly moist			
5					
6					
7		Test pit terminated at 6.5 ft; groundwater not encountered.			
8					
9					
10					

TEST PIT NO. 8

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with fine roots, moist (TOPSOIL)			
2	ML	Brown-gray, soft, silty fine SAND to fine sandy SILT, moist			
3	ML	Light-brown to light-gray, very-stiff to hard, fine-sandy to clayey SILT, moist			
4					
5					
6		Test pit terminated at 5.0 ft; groundwater not encountered.			
7					
8					
9					
10					

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JOB NO. 12-079 DATE 8/23/2012 PLATE 7

TEST PIT NO. 9

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with roots to 1-in ϕ, slightly moist (TOPSOIL)			
2	SM	Brown, loose to medium-dense, silty fine SAND, trace gravel, slightly moist			
4	ML	Light-gray, very-stiff to hard, fine-sandy to clayey SILT, slightly moist			
9		Test pit terminated at 8.5 ft; groundwater not encountered.			

TEST PIT NO. 10

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with fine roots, slightly moist (TOPSOIL)			
2	SM	Brown, loose to medium-dense, silty fine SAND, slightly moist			
3	ML	Light-gray, very-stiff to hard, fine-sandy to clay SILT, moist			
8		Test pit terminated at 7.5 ft; groundwater not encountered.			

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JOB NO. 12-079 | DATE 8/23/2012 | PLATE 8

TEST PIT NO. 11

Logged By: JSL Date: 8/22/2012 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown to black, loose, organic, silty fine SAND, with roots, slightly moist (TOPSOIL)			
2	ML	Brown-gray, soft, fine-sandy to clayey SILT, moist			
3	ML	Light-gray, very-stiff to hard, fine-sandy to clayey SILT, moist			
4					
5					
6					
7		Test pit terminated at 6.0 ft; groundwater not encountered.			
8					
9					
10					

TEST PIT NO. 12

Logged By: JSL Date: 5/17/2013 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown to black, loose, organic, silty fine SAND, with roots, slightly moist (TOPSOIL)			
2	ML	Brown, medium-dense, silty fine SAND, with roots to 2-in diameter, moist			
3					
4	ML	Tan to light-brown, with yellowish stains, very-stiff to hard, clayey SILT, trace gravel and occasional cobble, moist			
5					
6					
7		Test pit terminated at 6.5 ft; groundwater not encountered.			
8					
9					
10					

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JOB NO. 12-079 | DATE 8/23/2012 | PLATE 9

TEST PIT NO. 13

Logged By: JSL Date: 5/17/2013 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, with roots, moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, trace gravel, moist			
3					
4	SM	Gray, dense, silty fine SAND, dense, moist trace gravel and occasional cobble, moist			
5					
6					
7					
8		Test pit terminated at 7.5 ft; groundwater not encountered.			
9					
10					

TEST PIT NO. 14

Logged By: JSL Date: 5/17/2013 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown to black, loose, organic, silty fine SAND to fine sandy SILT, with fine roots, moist (TOPSOIL)			
2	ML	Light-brown to tan, with yellowish stains, stiff to hard, clayey SILT, moist			
3					
4					
5					
6		Test pit terminated at 5.0 ft; groundwater not encountered.			
7					
8					
9					
10					

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JOB NO. 12-079 DATE 8/23/2012 PLATE 10

TEST PIT NO. 15

Logged By: JSL Date: 5/17/2013 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, trace gravel, with roots, moist (TOPSOIL)			
2	SM	Brown, medium-dense, silty fine SAND, some gravel, slightly moist			
3					
4	ML	Light-brown to tan, with yellowish stains, very-stiff to hard, clayey SILT, moist			
5					
6	SM	Gray, dense, silty fine SAND, some gravel and occasional cobble, moist			
7					
8		Test pit terminated at 6.5 ft; groundwater not encountered.			
9					
10					

TEST PIT NO. _____

Logged By: _____ Date: _____ Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

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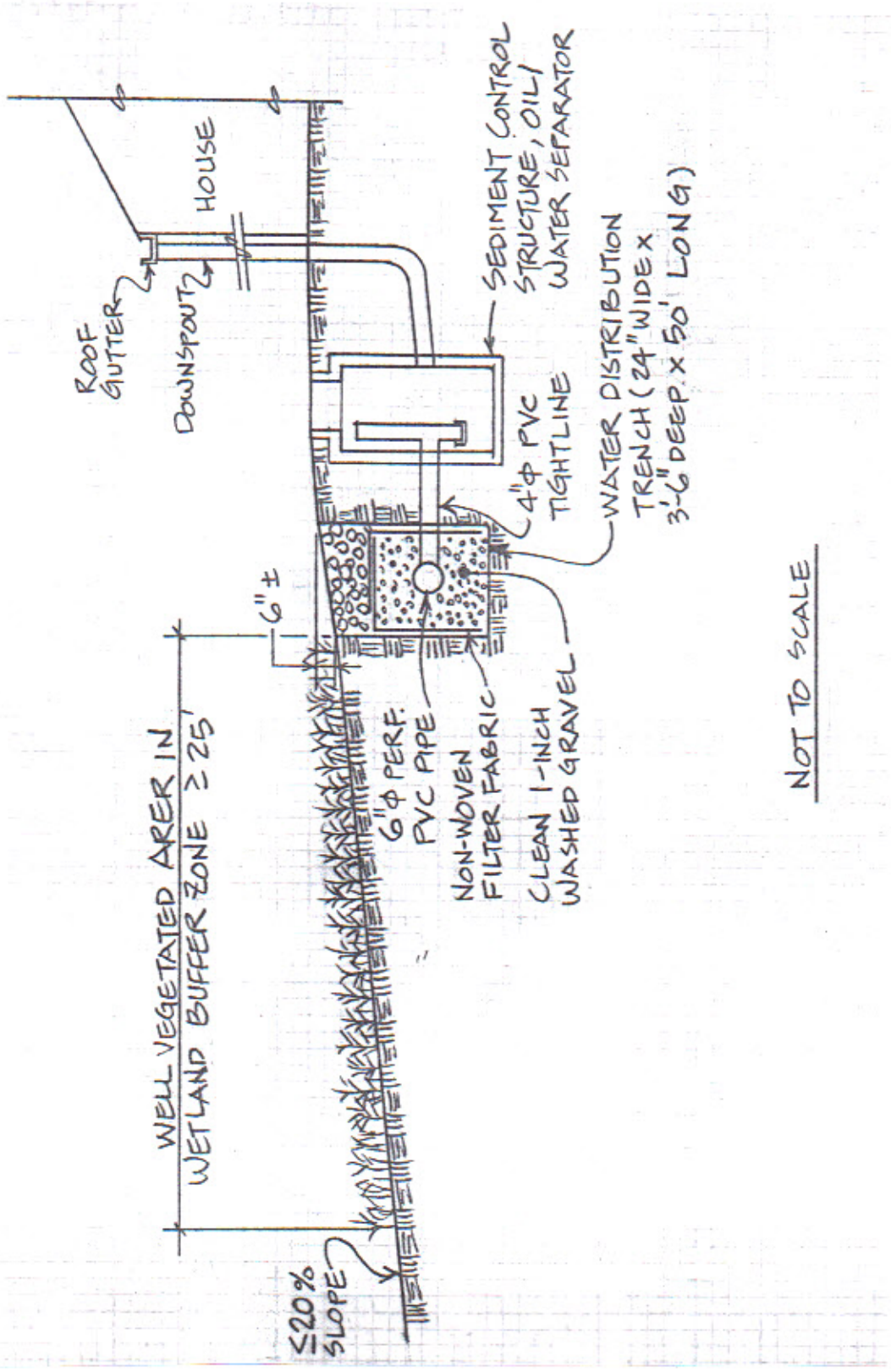
JOB NO. 12-079 DATE 8/23/2012 PLATE 11



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DISTRIBUTION TRENCH SYSTEM
BEAR MOUNTAIN SUBDIVISION
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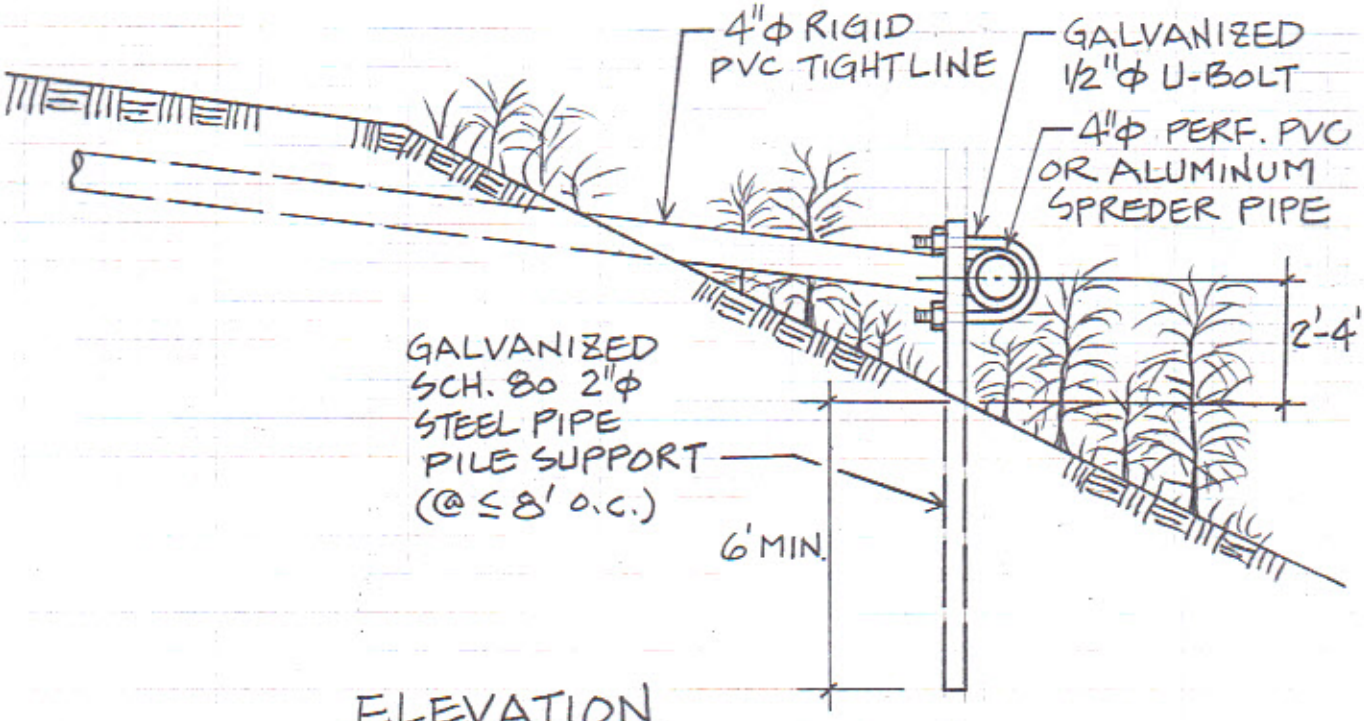
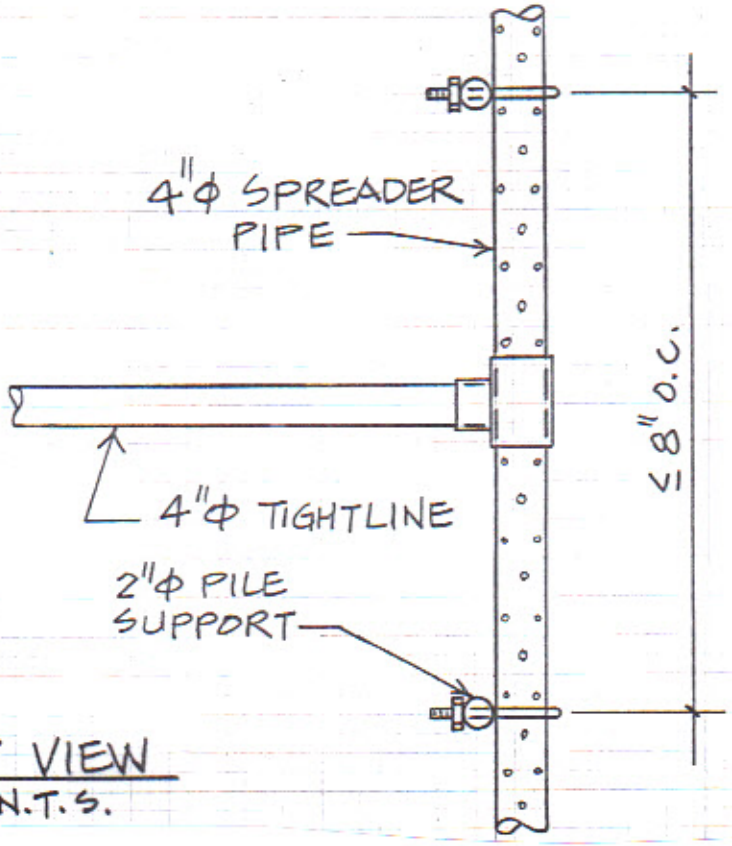
JOB NO. 12-079 PLATE NO. 12



ELEVATION
N.T.S.



TOP VIEW
N.T.S.

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SPREADER PIPE DISPERSION SYSTEM
BEAR MOUNTAIN SUBDIVISION
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BOTHELL, WASHINGTON

JOB NO. 12-079 PLATE NO. 13